BULLETIN

OF THE

Society for the Promotion of Engineering Education

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EDITORIALS.

The Joint Committee.—The report of progress in the study of engineering education, which is being conducted by the Joint Committee on Engineering Education, printed in this number of the BULLETIN, describes in a brief way four lines of work which have been started and gives an idea of what may be expected in the future.

When Dr. D. C. Jackson, then President of the Society, proposed the organization of a joint committee and outlined in a brief way the work which it might undertake, many were afraid or many believed such a study would resolve itself into an investigation of the non-essentials or the red tape of engineering education, a sort of classification of engineering colleges. That any such idea was far from the minds of the committee was at once evident when they selected Dr. Mann, who is not an engineer but a trained physicist and a well-known educator, to conduct the study for the committee in conjunction with the Carnegie Foundation for the Advancement of Teaching. The policy of the committee in making a detailed study of a few typical institutions rather than an attempt to study all engineering colleges, is to be commended. The essentials of engineering education are, or should be, the same for all schools. By securing a large amount of information in specific topics from a large number of engineering schools, classifying it carefully, the committee hopes to secure information which will show to educators those fundamentals upon which the greatest weight should be placed in the preparation of young men for the engineering profession. Teachers of engineering will await with a great deal of interest further reports from this committee.

The Cleveland Engineering Society issued in June, 1915, a most interesting "Good-Will" number of the *Journal* of that Society. The number is intended to promote peace. Since technical journals very seldom concern themselves with civic matters it demonstrates the fact that engineers are more and

more interesting themselves in public questions. A letter from the Engineering Society to the editor says: "As engineers, the eight hundred members of our society propose to interest themselves in large public questions. We think it is the new leaning in our profession. We desire to call the attention of younger and student engineers to this new vision of the senior members of our profession." If you want to see an Engineering Society journal that you will enjoy from cover to cover, get a copy of this number.

SOCIETY NOTES.

We reprint below two cards received from Dean A. A. Potter, of the Kansas State Agricultural College. The first is of interest in connection with the local section of the S. P. E. E. organized last year and commented on in the June BULLETIN.

MEETING OF THE DIVISION OF ENGINEERING

Divisional Faculty and Section of

S. P. E. E.

Engineering Amphitheater

Date .....at 3:30 P. M.

A. A. POTTER.

The second card shows the record kept of the "Character and Personality" of the students. The marks have the same significance as when applied to course subjects, viz., Excellent, Good, Passed, Conditioned, and Failed. This card is printed because of the increasing attention given to the problem of grading students in school in such a way that the record will be of value and can be used as a basis of making recommendations after the student has been graduated.

CHARACTER AND PERSONALITY RECORD

Division of Engineering

Kansas State Agricultural College

Name .....

Course ..... Date .....

Course furnished by .....

	Grade.	Remarks.
Ability	E G P C F	
Accuracy	E G P C F	
Coöperation	E G P C F	
Disposition	E G P C F	
Industry	E G P C F	
Initiative	E G P C F	
Judgment	E G P C F	
Personal Appearance	E G P C F	
Reliability	E G P C F	
Use of English	E G P C F	

APPLICANTS FOR MEMBERSHIP.

ENGEL, GODFREY, Engineer of Construction, American Sugar Refining Co. of New York, Brooklyn, N. Y.

FETTER, F. A., Professor of Economics, Princeton University, Princeton, N. J.

HALLOCK, J. W., Instructor in charge of Coöperative Work, University of Pittsburgh.

MCLEOD, D. F., Assistant Professor of Civil Engineering, University of Mississippi, University, Miss.

BOOKS RECEIVED.

Properties of Steam and Ammonia. By G. A. GOODENOUGH. Published by John Wiley and Sons, Inc.

The Essentials of Descriptive Geometry. By F. G. HIGBEE. Published by John Wiley and Sons, Inc., New York. Price $1.80 net.

Concrete-Steel Construction. Part I, Buildings. By HENRY T. EDDY and C. A. P. TURNER. Published by the authors.

How to Make a Transformer for Low Pressures. By F. E. Austin. Published by the author at Hanover, N. H. Price $0.25.

Directions for Designing, Making, and Operating High-Pressure Transformers. By F. E. Austin. Published by the author at Hanover, N. H. Price $0.50.

Examples in Alternating Currents. Vol. I. By F. E. Austin. Published by the author at Hanover, N. H. Price, paper cover, $2.00, flexible leather, $2.40.

Descriptive Geometry. Third Edition. By H. W. Miller. Published by John Wiley and Sons, Inc., New York. Price $1.50 net.

The Railroad Taper. By Lee Perkins. Published by John Wiley and Sons, Inc., New York. Price $2.50 net.

The Electric Railway. By A. Morris Buck. Published by McGraw-Hill Book Co., New York. Price $3.00 net.

Tests of Submerged Orifice Headgates for the Measurement of Irrigation Water. By F. L. Bixby. Being Bulletin No. 97, New Mexico College of A. and M. Arts.

There came to the editor's desk last spring too late for notice, a copy of a special souvenir number of *The Round Up*, the weekly student publication of the New Mexico College of A. and M. Arts. This number was worked up by the engineering students to mark the passing of the old and the beginning of the new order in the engineering department. It is an unusually good specimen of student journalism.

BOOK REVIEWS.

Analytic Geometry of Three Dimensions. Volume II. (Fifth edition.) By George Salmon, late Provost of Trinity College, Dublin. Revised by R. A. P. Rogers, Fellow of Trinity College, Dublin. 8vo, cloth, 350 pages, price $2.25. Longmans, Green, & Co., New York. 1915.

This book, together with Volume I by the same author, form a clear and comprehensive treatise on the subject of tridimensional geometry. While in many cases the valuable

material of the fourth edition has been rearranged, and sometimes rewritten, this edition has retained practically all of it and contains, in addition, a good deal of new and interesting matter under the headings: Rectilinear Complexes, Rectilinear Congruences with special emphasis upon their differential properties and also upon the optical and mechanical characteristics on normal congruences, Triply Orthogonal Systems, Cubic and Quartic Surfaces, and Cremona Transformations.

In Chapter XVI, the author has added a full bibliography of work done on the quartic surface, and in most cases throughout the book he has furnished ample references to guide those who wish to specialize further in the subject.

F. J. H.

Examples in Alternating Currents. Vol. I. By F. E. AUSTIN. Published by the author at Hanover, N. H. Price, paper cover, $2.00, flexible leather, $2.40.

While the title of this book indicates the purpose, it by no means indicates the scope. It is almost a text-book in its treatment of alternating currents and alternating current circuits. The author very evidently had in mind the teacher, the student, and the practicing engineer while preparing the book.

For the teacher it contains a well-ordered list of problems classified under the proper subheads; for the student it contains in addition to explanatory matter covering each type of problem, an example completely solved, and a review of the mathematics involved; and for the practicing engineer it furnishes a logically planned review of the whole subject of alternating quantities and the solution of alternating current circuits. Some unusual tables are included. The calculus is freely used and the fundamentals of calculus and trigonometry are reviewed as they become necessary to the solution of problems.

L. H. H.

PERSONALS.

Professor Alfred Still, of Purdue University, who was homeward bound on the ill-fated *Arabic,* landed in New York September 5, on the *Cameranian,* and has resumed his duties at Purdue.

Dr. J. A. L. Waddell announces that his son, N. Everett Waddell, has become his partner under the firm name of Waddell and Son, with offices at 800 Graphic Arts Building, Kansas City, Mo.

Dr. A. S. McAllister, associate editor of the *Electrical World* since 1905, has resigned. Dr. McAllister is widely known as a writer and inventor as well as an educator. It is to be hoped that his new field of activity will not lessen the opportunities for contact with the problems of technical education.

COLLEGE NOTES.

Municipal University of Akron.—The Engineering College of the University of Akron is entering upon the second year of its existence with every promise of success. The Cincinnati plan or the coöperative system is in operation here and the manufacturers have taken very kindly to it. Twenty-eight students were entered last September and twenty-one of these registered in September for the second year work. The entering class is practically the same size. Through the generosity of two of our prominent citizens there is in course of construction a $30,000 library building which will add materially to the available teaching space in our present buildings and also furnish in addition to the general reading room, club rooms for the boys and girls.

Case School of Applied Science.—The following appointments to the faculty have been made: Keith F. Adamson, of the University of Pennsylvania, as Assistant Professor of Mechanical Engineering; Melville F. Coolbaugh, of the South Dakota School of Mines, as Assistant Professor of Chemistry; Roy E. Spencer, of Harvard University as Instructor in Eng-

lish; Lawrence G. Wesson, of Harvard University, as Instructor in Organic Chemistry; Carl H. Wilson, of Harvard University, as Instructor in Chemistry; Arthur E. Bradley, recently of Cornell University, as Instructor in Civil Engineering; Allan A. Prior, Harvard University, as Instructor in Electrical Engineering; Perry F. Ellsworth, of the Edison Electric Company, as Instructor in Electricity and Drawing; R. B. Reis, of the Westinghouse Electric Company, as Instructor in Mechanical Engineering; H. F. Pasini, Graduate of the Y. M. C. A. Training School of Springfield, as Director of the Gymnasium; and Bohlis Dahlman, Instructor in Gymnastics.

Cornell University.—Alexander M. Gray has been elected professor of electrical engineering and head of the department of electrical engineering in Sibley College. The head professorship of electrical engineering in Sibley College was resigned two years ago by Professor H. H. Norris. Professor Vladimir Karapetoff has been acting head of the department during the interval.

University of Florida.—The professorship of mechanical engineering, made vacant by the resignation of Professor A. J. Wiechardt, will be filled next year by Professor R. E. Chandler, now of New Hampshire College of Agriculture and the Mechanic Arts.

Iowa State College. *Agricultural Engineering.*—Professor M. F. P. Costelloe has been appointed Acting Head of the Department to take the place of Professor Davidson, resigned. Mr. Mark Havenhill, Instructor, has resigned to resume his course in Agricultural Engineering. Mr. George W. Iverson, of Ames, has been appointed Instructor in Agricultural Engineering in graphic methods and in farm structures. Mr. H. C. Gruwell, of West Branch, Iowa, has been appointed mechanician for the Agricultural Engineering Department to take the place of Mr. E. V. Collins, resigned, who goes to accept a similar position with the Kansas State College. Mr.

H. F. Hertz, of Ames, Iowa, has been appointed to the instructorship in forge work. Mr. A. R. Williams of Laramie, Wyo., has been appointed Teaching Fellow in the Department.

Ceramic Engineering.—In Ceramic Engineering H. F. Staley has been made Associate Professor. Grover Babcock, of Wellsville, N. Y., has received a research fellowship in this department.

Chemical Engineering.—The vacant Associate Professorship in this department has not yet been filled.

Civil Engineering.—Mr. C. A. Baughman has been made instructor in Civil Engineering.

Electrical Engineering.—A new department in telephone engineering has been established. Mr. C. A. Wright of New York City, who was with the American Telephone and Telegraph Company of that city, has been made Associate Professor. Special work in telephone engineering is now offered in the electrical engineering course, open to Seniors. A new telephone laboratory is being equipped. This department is working in coöperation with the telephone operators of the State. The college wireless station is now to be used by the U. S. Weather Bureau to distribute weather predictions to the 30 or 40 amateur wireless stations in the state. In electrical engineering the headquarters of the department are moved to the Engineering Annex. Additional office and laboratory room has been assigned to the department there.

Mechanical Engineering.—Professor R. H. Porter has resigned, to take charge of the mechanical engineering department at the New Hampshire State College. Mr. Ollison Craig, Experimental Engineer of the Chain Grate Stoker Department of the LaClede Fire Clay Products Company of St. Louis, Mo., has been appointed to the vacancy caused by Professor Porter's resignation. Professor R. A. Leavell has been appointed Associate Professor in the mechanical department in charge of automobile engineering. Mr. Leavell was formerly Manager of the Edwards School of Motoring, Chicago, Ill. He will devote half time to the work in the Mechanical

Engineering Department, and one half time to the Automobile Institute work of the Engineering Extension Department. Mr. C. W. Beese has been appointed to a new instructorship in drawing in Mechanical Engineering.

Physics.—Two new instructorships have been created. Mr. W. Neuswanger, of the University of Nebraska, and Mr. F. J. McGrath, of the University of Michigan, have been appointed to these two positions. The Physics Department has equipped an additional general Physics lecture room in Engineering Hall, and new Physics laboratories for Agricultural and Home Economics students in the Engineering Annex.

Structure Design.—Harold Sprague, who is an architectural graduate of the University of Illinois, has been appointed to a new instructorship.

The University of Kansas.—J. O. Jones, Assistant Professor of Hydraulics, after a year's leave of absence for study at Cornell University, returned to the university September 1 and will have charge of the work in Hydraulics. C. A. Haskins, Associate Professor of Sanitary Engineering, will return to the university October 1 after four months' leave devoted to government work under the Public Health Service. Most of his time has been spent on the coast of New Jersey in determining the pollution of oyster beds and tidal waters. Prof. C. M. Young has resigned from the position at the head of the work in Mining Engineering. Last year he was on leave of absence during the first semester, engaged in government work on the pollution of streams by mine waters in the Pittsburgh district. In January he was elected to the editorship of the *Colliery Engineer* and moved at once to Scranton, Pennsylvania, to take up the duties of the new position. Prof. A. C. Terrill has been appointed head of the department of Mining Engineering to fill the vacancy made by the resignation of Prof. C. M. Young. Prof. Terrill was formerly at the Universities of Idaho and Oregon. Mr. Richard L. Grider was appointed instructor in the Mining Department. Prof. A. H. Sluss has been advanced from grade

of Assistant Professor to Associate Professor of Mechanical Engineering. Assistant Professor F. E. Jones has been elected Superintendent of Fowler Shops. F. Ellis Johnson has been appointed instructor in Electrical Engineering. He is a graduate of the University of Wisconsin in 1909 and has been teaching during the past three years at the Rice Institute, Houston, Texas. H. H. Curfman has been appointed instructor in Electrical Engineering. He was a member of the class which graduated in June. Willis G. Whitten has been added to the department of Architecture as an assistant instructor.

On Tuesday of Commencement week last June, occurred the unveiling of the bronze portrait bust of former Dean F. O. Marvin. The alumni of the school had contributed for the portrait and as a part of the setting, book-cases had been constructed in which is installed the personal technical library which Dean Marvin had collected during his long years of service. The setting is in the Library room of the School of Engineering, occupying one entire wall. At the exercises a goodly number of alumni and former students was present.

At the meeting of engineering alumni of the School at the time of the unveiling of the Marvin portrait a permanent organization was formed. Through this organization it is thought that alumni may be led to take a more active interest and to promote certain activities of professional interest. Committees have been established for the purpose of organizing a corps of graduate lecturers, for maintaining a more complete record of graduates and for promoting the support by alumni of the various publications. Professor B. J. Dalton, of the Class of 1890, formerly at the head of the railway and civil engineering department and now on leave of absence and engineer with the Railway Valuation Board of the Interstate Commerce Commission, is president of the association.

Kansas State Agricultural College.—The teaching and research work in the Department of Farm Machinery formerly given in the Division of Agriculture has been transferred to

the Division of Engineering and a new department of Farm Machinery organized with F. A. Wirt in charge.

Mr. W. A. Etherton, for the past few years in charge of rural architecture in the U. S. Department of Agriculture, and formerly Professor of Architectural Engineering at the Oklahoma A. & M. College, was elected Professor of Rural Architecture.

E. V. Collins, of the Iowa State College, was elected Assistant in the Steam and Gas Engineering Department.

Professors Conrad and Frazier, of the Department of Civil Engineering, were engaged in irrigation engineering work at Wyoming during the summer.

G. B. McNair, of the Electrical Engineering Department, was with the Westinghouse Company during the summer and W. H. Sanders, of the Steam and Gas Engineering Department, has been with the International Harvester Company.

Lafayette College.—Lafayette has sustained a distinct loss in the death of Prof. Alvin Davison, Head of the Department of Biology. Professor Davison died in Cincinnati on July 31. Professor Davison was connected with the Department of Biology at the college from 1894 till the time of his death.

The arrangements for the inauguration of Dr. John Henry MacCracken as President of the College are in the hands of Dr. J. George Becht, Secretary of the Board of Education of the State of Pennsylvania. The inauguration will be held on October 19 and 20 in Easton. Dr. MacCracken, lately Syndic of the New York University, was elected to the Presidency of Lafayette in December of last year. He has been in charge of affairs at the College since February. Prof. J. Madison Porter, head of the department of Civil Engineering is chairman of the local committee on reception and entertainment.

A new course in Municipal Sanitation is being offered by Prof. William T. Lyle who is connected with the Department of Civil Engineering. This course will be given to the senior class in civil engineering and will be elective to several of the other courses.

University of Maine.—Professor W. J. Sweetser, formerly Assistant Professor of Mechanical Engineering at Case School of Applied Science, has been elected Professor of Mechanical Engineering.

University of Missouri.—Mr. A. C. Lanier has been appointed Professor of Electrical Engineering. Mr. Lanier comes to Missouri from the Westinghouse Electric and Manufacturing Company, where he was head of the direct-current machinery design. Mr. Lanier has had teaching experience at the University of Tennessee and at the University of Cincinnati.

At the meeting of the Board of Curators last week, the following promotions in the School of Mines Faculty were made: Austin L. McRae, Professor of Physics, was elected Director; J. W. Barley, Associate Professor of English, was made Professor of English; J. C. Ingram, Instructor in Chemistry, was made Assistant Professor in Chemistry; C. Y. Clayton, Instructor in Metallurgy, was made Assistant Professor of Metallurgy. Durward Copeland, Professor of Metallurgy, was given a year's leave of absence and expects to spend the year in experimental work on tin for the Llallagua Tin Co., Bolivia, South America.

New Mexico College of A. and M. Arts.—A new department devoted to irrigation engineering has been started. This phase of engineering is of vital importance to the development of the Southwest. Mr. Raymond Mathew, a graduate of the University of California, and with experience in this line in Southern California, will head the work.

University of Notre Dame.—The registration of engineering students last year was the largest in the history of the University, and judging from the number of inquiries and applications thus far received, this year's enrollment will exceed that of last year. The Faculty realized some time ago that additional space would soon be needed to meet the requirements of the growing attendance, and it was confidently

expected that work on a new building would begin this summer; but owing to other and important matters that unexpectedly arose during the school year, and demanding immediate attention, the Faculty decided to defer the contemplated improvements in the engineering department for another year. This postponement, however, will not seriously inconvenience the department as ample room can be provided for the present by making a few minor alterations in the present arrangement.

The electrical department has added to its shop equipment, thus making it quite complete for all experimental and practical purposes, and the same may be said of the mechanical laboratory. The same heads of departments will continue as last year and only minor changes among the assistants have been made. A more extended course of study, both theoretical and experimental, in concrete construction, plane and reinforced, will be given to the civil engineering students during the coming year; and also a course in economics has been added. With these minor changes the present curriculum which is now quite complete will be given. The aim of the Faculty of this University is to offer a course of study that will prepare young men to become not only thoroughly technically trained engineers, but also qualified to meet the requirements of the fully educated and trained man of the world.

University of Pittsburgh.—The success of the Evening School of Engineering during the season of 1914–1915 and the continued inquiries for such work the faculty of the Engineering School has decided to offer the courses again during the coming winter. Each department of the Engineering School offers one or more courses of graduate work.

Mr. R. L. Glass comes to the department of electrical engineering as instructor from the General Electric Co. Mr. Glass takes the place made vacant by the resignation of Mr. W. P. Powers who is now with the National Electric Signalling Co. at the Brooklyn laboratory.

Stevens Institute of Technology.—Professor Thomas Bliss Stillman, until 1909 head of the department of Chemistry when he retired on a Carnegie pension, died on August 10 at the age of sixty-three. Mr. Samuel H. Lott, instructor in Descriptive Geometry and Mechanical Drawing has been appointed Assistant Professor. Mr. L. C. F. Horle, assistant in Physics, and Mr. Lewis A. Belding, assistant in Electrical Engineering, have been made instructors. Mr. Reiman G. Erwin, Pennsylvania State College, has been appointed Laboratory Assistant in Chemistry. Mr. Donald Mackenzie has been made Instructor in French and Spanish.

As a result of the revision of the curriculum the Mechanics formerly given in the freshman year will be given in the first term of the sophomore year and all the sophomore Mechanics will be given in the second term. Hydraulics, heretofore spread over the entire junior year will be given in the first term.

A seven-acre tract of land adjoining the Athletic Field was purchased during the summer.

Agricultural and Mechanical College of Texas.—Professor E. W. Kellogg has been appointed Assistant Professor of Electrical Engineering. Professor Kellogg comes from the University of Missouri.

University of Utah.—Among those who have been recently appointed to the Faculty of the University of Utah are: Dr. Walter D. Bonner, formerly Assistant Professor of Chemistry in the School of Mining in Queen's University, who becomes Head of the Department of Chemistry, and Dr. Elton L. Quinn who becomes Assistant Professor in the same Department. Dr. Orin Tugman resigns a position as Research Physicist with the Eastman Kodak Company to become Associate Professor of Physics. The Metallurgical Research Department of the Utah State School of Mines, the Engineering college of the University of Utah which was established two years ago, has now become well organized. This Department

is run in coöperation with the United States Bureau of Mines and is under the immediate charge of D. A. Lyon, metallurgist of the United States Bureau of Mines. Ten men besides Mr. Lyon are devoting their entire time to metallurgical investigations. Among these are six research fellows who are carefully selected from applicants all over the country. It is the policy of this department to admit appointees of industrial companies for special investigation in the field of metallurgy, during the past year seven appointees of this place having worked on their special problems.

University of Virginia.—Announcement was made during Finals Week of the promotions of Associate Professor Charles Hancock to Professor of Mechanical Engineering and of Instructor Jared S. Lapham to Adjunct Professor of Applied Mathematics. Mr. Miles F. Trummell, who was Instructor in Physics and Electrical Engineering during the session of 1914–15, has left the university and is at present employed by the Public Service Company of Northern Illinois at Waukegan, Illinois.

Two gifts of $20,000 each were announced by the President in June, both to be used toward the construction of a new chemical laboratory.

Plans are under way for the remodeling of the heating system of the university and it is expected that a new and modern central heating plant will soon be commenced.

The equipment for laboratory instruction in testing of materials for highway work has been greatly augmented during the past year and is now adequate for thorough tests of both bituminous and non-bituminous road materials.

A course of five lectures on modern road building by Dr. L. I. Hewes, of the U. S. Good Roads Bureau, was a feature of the special Highway course during the winter term.

Professor Hoxton, of the Physics Department, has recently completed the installation of a wireless receiving station from which time signals are received daily from Arlington. It is

hoped that a sending set may be installed soon, thus giving opportunity for practice in wireless telegraphy to those students who may be interested.

Dean William M. Thornton, of the Engineering Department, recently delivered a series of lectures at the University of North Carolina. These lectures mark the initiation of an exchange lectureship between the University of Virginia, the University of North Carolina and Vanderbilt University.

A REPORT OF PROGRESS IN THE STUDY OF ENGINEERING EDUCATION.

BY C. R. MANN,

Carnegie Foundation for the Advancement of Teaching.

Dean Anthony has correctly stated that this is a coöperative study of engineering education. He has just been rejoicing over the fact that he has had the year off, with only one or two pleasant meetings in various places, talking over the work. I want to give warning, however, that this is only the calm that precedes the storm. For so soon as we have the material organized in a form in which it is amenable to criticism and suggestion, the committee is going to hear from us. I hope that this will be early in the fall; and from that time on you may expect a very active coöperation between the committee and the Foundation office in regard to the further development of the work.

This is a preliminary report of progress. I shall, therefore, merely describe in the briefest possible way the four lines of work that have been started, and the general indications up to the present time.

The first of these four lines deals with the origin, development and progress of engineering schools. It seems important that we should understand why it was that engineering schools, with the exception of the Rensselaer Polytechnic at Troy, suddenly sprang into prominence in this country after the Morrill legislation in 1862. Was this an unexpected growth that sprang up as it were over night? or was its advent prepared by a long series of incidents? I have been very much surprised, as the committee has been, to find that the public demand for an education for use was clearly expressed at a very early date and that it became more and more insistent as the industries of the country developed.

The first clear statement of the importance of education

for use appears in Benjamin Franklin's well-known pamphlet on "The Education of the Youth of Pennsylvania," in which he urged the introduction into the schools of those subjects and methods which would conduce to the largest public utility. That the importance of practical education for all, in addition to the usual ornamental education for a few, was recognized by Washington is shown by his remarks in his message to Congress on December 7, 1796, in which he calls their attention to the necessity of action to encourage agriculture. The committee to which this suggestion was referred reported that the best means of promoting agriculture was to give the farmers the easiest means of acquiring the best information concerning the management of farms and to excite in them a spirit of enquiry, industry and experiment. In 1814 Jefferson wrote "I have long been collecting materials for the plan of a university in Virginia which should comprehend all the sciences useful to us, and none others." His plan for a "school for technical philosophy where the higher branches should be taught in abridged form to meet the practical need" in addition to the usual literary college for pure culture, was never realized.

In 1785 the Philadelphia Society for the Promotion of Agriculture was established and the Society of Mechanics and Tradesmen in New York was organized. In 1819 the New York legislature appropriated $10,000 a year for two years for the "promotion of agriculture and family domestic manufactures." The next year the Pennsylvania legislature appropriated funds for the promotion of "agriculture and domestic manufactures." In 1823 the Committee on Agriculture of the State Legislature in New York presented a fine plan for an agricultural school and urged the state of New York to establish and support it at public expense. This report outlines in detail the organization and the curriculum of the school that was then wanted; it describes fairly well the type of school which after years of experiment has eventually been evolved; thus showing that the idea of what was

needed and wanted was clearly in mind as far back as 1823. One interesting point is that this report ascribes this plan directly to the Fellenberg school at Hofwyl, Switzerland. This school, you probably all know, was organized by Pestalozzi and his pupil, Wehrli. The fundamental idea of this school was that of making labor a principal means of training the young. Henry Barnard states that because of the methods developed at this school, Switzerland obtained a system of public education whose foundations were the wants of the nation; and the idea of training by productive and civilizing labor was advanced from theory to practice.

From 1823 to the passage of the Morrill Act in 1862 many organizations like the Franklin Institute, the Ohio Mechanics Institute, and various state agricultural societies were established, all for the purpose of securing more useful education. In 1837, when John Smithson bequeathed to the United States $500,000 for the "increase and diffusion of knowledge among men," several suggestions were made for the use of part of this fund for the encouragement of useful education. After nine years' consideration Congress made other disposition of the fund. Another quarter of a century had to elapse before the government recognized that the foundation of a true democracy is a system of public education which effectively meets the needs of all the people and passed the Morrill Act.

It is thus perfectly clear that the people in the early history of this country had a very definite idea of what they meant by education in agriculture and the mechanic arts and of how schools should be organized to secure it. It is also perfectly clear that when schools of agriculture and the mechanic arts were established after 1862, they did not at first succeed in accomplishing the purpose for which they were established. It is only within the last twenty years, perhaps, that the schools have really developed an organization and method of teaching that bids fair to give the people what they have so long sought in vain.

The main conclusion, perfectly evident on the face of the

facts, is that the people in the early history of this country had a very definite opinion, very clearly explained in early documents, of the type of education that they wanted. The schools that were established for that purpose have achieved that ideal in a very marked degree only in the last few years.

The second line of investigation has been aimed at finding what the engineering profession wants. This has been done in two ways: first, by many personal interviews with engineers in practice and with schoolmen on the subject; and second, by sending out a circular letter, which many of you have received, asking a few leading questions. These letters were sent by the engineering societies to their membership—23,000 were sent out in all. The suggestions secured from these interviews and these letters are not yet classified. There are, however, certain ideas that occur so frequently that you cannot fail to be impressed by them even after a cursory examination.

In questioning the efficiency of the engineering schools at the present time there are four conspicuous things in which the professional men show a fair degree of unanimity. The first and most important is English. A large majority of the letters received mention the absolute necessity for higher efficiency in the training in English. One engineer states that faulty English wastes each year more money than would pay the United States debt. Engineers should be able to express their precise ideas clearly and accurately, and should be certain that their words convey to another the thoughts that they wish to express.

This criticism of English is a very far-reaching one because English depends on so many things—inheritance, home environment, youthful associations, early schooling, social opportunities, and the like. But clear expression in English depends even more on how the engineering subjects are taught. No one can express himself clearly unless he has been taught in the science and engineering departments to think clearly. No one can write a convincing report unless he has learned to

discriminate between essential and unessential elements, between important and unimportant factors,—in other words, he must have acquired perspective. This problem of more efficient English involves the whole school and it cannot be effectively solved without the earnest and sincere coöperation of all the departments.

The second point which is prominent in the professional criticism of engineering schools is the engineer's breadth of view. The present importance and the rapidly expanding scope of the engineering profession demands men with vision, enthusiasm, and sympathy,—men with ideals and faith in human nature. At present, public service commissions are usually composed of lawyers, men of business, perhaps doctors and possibly theologians. These men make the general plan for new roads and decide which road shall be improved first to meet the social needs of communities. Then engineers are employed to do the technical work of construction. Men of broader social outlook and broader appreciation of human relations lay out the larger plan; the technical details are too frequently the sole inheritance of the engineer.

A large majority of the practicing engineers suggest that the kind of breadth that is wanted may be developed by more study of sociology, economics, history, psychology and ethics, rather than by the usual haphazard efforts at securing some knowledge of foreign languages. A reading knowledge of French and German does not seem to be essential for the engineer, although some still cling to the old ideas of the efficacy of mere language study in developing culture. Spanish may be more desirable because of its utilitarian value.

The third important point in the professional criticism is the lack of what they call business sense. They do not expect the student to know the exact prices of cast iron or brass per pound; but they do want him to know instinctively that if he figures the cost of forty tons of cast iron at two million dollars something is wrong with his calculations. It is a sense of relative values that seems to be needed. A competent

engineer is not a man who can design a bridge, but a man who can design the best bridge for the least money.

The fourth and perhaps the most important point on which many members of the engineering profession agree in criticizing the schools may be called over-specialization. Some state it by saying that there is too much specialization with a consequent lack of thoroughness in mastering fundamental engineering science. Others describe it as a failure to be able to apply general principles to practical problems. Too many technical details are taught, and too much time spent in describing industrial methods many of which are obsolete and all of which can be learned better after the student begins the particular practical work which he happens to take up after graduation. One well-known engineer and teacher quotes Huxley in explanation of this point as follows: "The knowledge I have looked for was a real, precise, thorough, and practical knowledge of fundamentals; whereas that which the best of candidates, in a large proportion of cases, have had to give me was a large, extensive, and inaccurate knowledge of superstructure."

These four points present the more comprehensive problems now facing the engineering schools as seen by those who have the opportunity of observing the way in which graduates function in practice. There is a vast amount of detailed suggestion in addition, but these leading ideas may serve to give some notion of the attitude of practicing engineers toward this second part of the study.

The third part of this investigation consists of an analysis of the work of some of the schools. I now come to the subject of classification, mentioned a little while ago. We are making no effort to classify engineering schools in any way, shape, or manner. This is a study of engineering education. We are trying to measure the efficiency of the current methods of instruction for educating engineers, and are not particularly interested in the classification of the schools.

I have already visited ten schools, spending from three or

four days to two weeks at each, have interviewed the members of the family very carefully, studied their texts, their notes, their examination papers, the records of the schools, etc.

One general method of analysis of the school work has turned out in practice to be very illuminating. This method was suggested by Dean Anthony in Boston one night last fall, when he said he had noted that in his school students in engineering did not do as good work in the second year as in the first, and he wondered why it was. He said other schools had noticed the same fact. About that time Mr. Humphreys, of the Massachusetts Institute, published his studies of the standing of students at that school, showing again that students make a lower average grade in the second year than in the first. The records of ten schools have been analyzed formally, and several others informally, and they all show the same drop in average grades in the second year.

As an example of the method we have selected five well-known and typical schools for presentation here. The average grades of the members of the graduating class for 1914 are as follows:

School.	Freshman.	Sophomore.	Junior.	Senior.
I	74.5	72.0	70.0	71.5
II	66.8	64.7	65.6	64.0
III	76.1	73.4	75.5	74.0
IV	79.6	77.0	77.3	87.3
V	67.0	65.2	68.2	

The average curve for these five schools is

Freshman.	Sophomore.	Junior.	Senior.
73.2	70.4	71.3	74.2

In order to discover what caused the sag in the second year, a note was made of every subject in which any student made a low record. Where the school rated students on the *A*, *B*, *C*, *D* scale, marks below *C* were considered low. Where a numerical scale was used with 60 as the pass mark, records below

70 were noted. When the pass mark was 70, records below 75 were noted.

The following table gives the number of students who had one or more low grades in the subjects specified. In all, 220 student records are here summarized.

Subject.	Number of Students Having Low Grades.	Percentage.
Physics	114	52
Mechanics	99	45
Foreign language	91	41
Calculus	79	35
English	78	35
Chemistry	46	22

All the other subjects in the curriculum have some low grades but none of them run over 5 or 10 per cent. All the above percentages would be higher if schools that grade on an *A, B, C, D* scale discriminated between a high *C* and a low *C*.

These figures show that the schools themselves realize that even the proficient students who are on the whole considered worthy of graduation have not done good work in physics, mechanics, foreign languages, calculus, English and chemistry, These subjects are the fundamentals on which the superstructure of engineering ultimately rests.

These facts present a very interesting problem. I am not yet prepared to give any answer to it. This is the situation, and if you will study your own records, you will, I think, find it is a fairly good summary of the general conditions. There are, of course, variations in the various schools. But we are not interested in the personal characteristics of the different schools or of the different departments in those schools; we are interested in the general problem, and this represents the general situation fairly accurately. I am glad to notice that we are to hear from the committees on teaching physics, on teaching mechanics, and on mathematics, and perhaps they will tell us how to cope with these conditions.

Whatever the recommendations of these committees may be, it is perfectly clear to all that there are as many different

methods of teaching as there are schools. This is evident also from the fact that the percentage of students who have low grades in physics varies in the schools studied from 14 to 62. This variation is due to so many individual and local causes that no one is willing to draw the conclusion that a low percentage means a high efficiency in teaching. Yet some less personal and more positive means of measuring teaching efficiency should be possible. The ordinary examination does not do it; is it not possible to find something that will?

Again, the figures given above are compiled from the records of those who graduated. They show the subjects in which the more competent students had difficulty, but take no account of the low grades of those students who were eliminated because of poor work. Yet in engineering schools in general about 50 per cent. of the entrants are eliminated before graduation. This indicates an enormous waste, both for the students and for the school, and shows clearly that the sorting out process at admission has an efficiency of only fifty per cent. It seems as if it ought to be possible to devise more efficient methods of finding out whether a boy shows promise of engineering ability. Engineering is a rather positive, definite thing, and it should be possible to find out by tests of one sort or another whether the boy really ought to study engineering or not. You *do* find it out in three or four years, but then there has been enormous waste. You should be able to find it out right away, when the boy presents himself for admission.

Another important problem is that of measuring the efficiency of the school as a whole. This is a complicated problem because certain schools get a higher type of material at entrance. They develop these young men in a particular way and they go out and make a great success. Other schools receive rather crude raw material, and though the product may not make so great a success, the school may have done more for their development than did the other type of school. It is hard, then, to say how much of that success is due to the innate ability of the students and how much is due to the

training they receive at the school. It seems to me conceivable, at least, that we might devise methods of measuring accurately how much of a student's progress is due to the school.

In order to assist the schools in making a more successful choice of material at entrance and in measuring more definitely the efficiency of the teaching in developing engineering ability, we have secured the assistance of Professor E. L. Thorndike, of Columbia University, who is conducting elaborate experiments in testing engineering freshmen and graduates. We have also organized a small committee consisting of three well-known engineers, Professor Thorndike and myself, for the purpose of planning, discussing and criticizing these experiments. We expect that this work will result in establishing types of tests that will enable the schools to increase their efficiency both in selecting the students for admission and in measuring the contribution of the school toward the progress of those students.

In brief, then, the work of the joint committee during the past year has been organized on the general plan of furnishing the schools with: (1) A history of their origin and development. (2) A statement of the professional demands they are trying to meet. (3) An analysis of their present conditions and methods of work. (4) A method of measuring their own efficiency in the admission and development of students. This is intended to give the schools a more definite conception of their purposes and ideals, an increased appreciation of the importance of a continuous scientific study of their own educational methods, and a more positive and objective method of measuring their own results.

SHOULD THESES BE REQUIRED?

BY L. F. VAN HAGAN,

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The committee has attempted to decide this question strictly upon its merits. The sentiment prevailed that the thesis was, in a manner of speaking, on trial and that, regardless of any odor of sanctity that might cling to it because of age or custom, it should be called upon the same as any other subject in the curriculum, to justify itself as part of the required work. It has been necessary, in pursuance of this idea, to seek answers to the following questions:

1. What is the purpose underlying the thesis requirement?
2. Is that purpose being accomplished?
3. Is that purpose of sufficient importance to justify the retention of thesis as a required part of the curriculum?
4. If the purpose is of importance, is thesis the best means of accomplishing it?

Since it was possible that it might be recommended to make thesis elective, it was thought necessary to obtain some idea as to the results to be expected under the elective system; accordingly letters were sent to a hundred or more technical schools inquiring about thesis practice and the results obtained therefrom. Seventy-two replies were received, most of them expressing a keen interest in the matter and giving much valuable information.

* *Author's Note.*—For some years there has existed at the University of Wisconsin a strong opposition to the thesis requirement. Last fall (1914) the matter again made its periodic appearance in the College of Engineering and was referred to a special committee, of which the writer was chairman, for consideration. The work assigned to this committee was that of investigating the question of making theses elective in the College of Engineering. The subject aroused much interest and discussion. The report of the committee, substantially as herewith presented, was concurred in by four of the six members and, after considerable discussion was accepted and approved by the faculty.

Seven meetings of the committee were held. Since there are, among the members of this faculty, widely diverging views upon the subject, several of the meetings were open to all faculty members so that all shades of opinion might be effectively presented.

No serious effort has been made to go into the early history of thesis for the purpose of determining the original idea behind the requirement. It was felt that such an investigation, however interesting it might be, could throw little or no illumination upon present conditions and difficulties.

Thesis Practice at Wisconsin.

Thesis Requirements.—Students in the College of Engineering are required to present a graduating thesis or to take a "thesis course." The provision in regard to thesis course was adopted in 1913 and is as follows:

"Students may, on approval of the Course Committee, submit in lieu of thesis, a course of not less than three credit hours in laboratory, design or seminary work, of as independent a nature as possible. Such course shall involve one or more written reports on correlated subjects which shall be carefully prepared with due attention to expression and form. After acceptance they shall be typewritten, bound and deposited in the library in the same manner as a thesis."

So far as the committee can learn, practically no efforts have been made to develop thesis courses or to encourage students to elect them. So far as actual results are concerned there might as well be no such provision. The seniors, with scarcely an exception, take regular thesis work.

Nature of Thesis.—An investigation into the thesis practice now prevailing in this college shows considerable divergence both in regard to the nature of the work assigned and in the methods of administration.

Experimental work, design and library research are all used for thesis investigation. The size of the problem selected also exhibits a wide variation. One extreme is the small prob-

lem that forms one of the details of some large problem. Such a problem is intended to be small enough to allow the student to become thoroughly familiar with it in the time available for thesis work. An example of a thesis of this size would be an investigation into the proper type of floor to use in a roundhouse. The other extreme in size is the study of a problem involving many of the small details. The principal object of such a thesis is to correlate principles and information already acquired in regular courses. It does not permit full investigation of any one detail. An example of such a thesis would be the design of an engine house layout, with its attendant track, fuel, and water facilities.

Administration of Thesis.—Practice in regard to the administration of thesis ranges from practically no supervision to the other extreme of requiring students to report in groups at regular periods in the laboratory or drafting room where they work under the immediate supervision of an instructor.

The members of the committee report their own practices as follows:

Professor Bennett: No set time for conferences. They are held as occasion demands and upon the initiative of either the student or the director of thesis.

Professor Holden: Requires thesis men to work in the drafting room under close supervision as in a drafting course.

Professor Kowalke: Meets all thesis men in one group, regardless of differences in thesis subject, one hour per week at stated periods.

Professor Maurer: Works on principle that the student develop initiative and a sense of responsibility. Throws him largely upon his own resources and does not require periodic conferences.

Professor Van Hagan: Requires thesis men to report once a week individually, for a half-hour conference and report of progress.

Thesis Practice in Other Institutions.

Information is available in regard to the practice in seventy-two other engineering schools.

Thesis Requirements: The practice in regard to thesis requirements for the baccalaureate degree may be summarized as follows:

1. Thesis required with no substitution permitted	33
2. No thesis requirement	20
3. Thesis optional, that is;	
(*a*) Thesis nominally required but the substitution of other courses permitted at option of faculty	4
(*b*) Better students only permitted to take thesis and at option of faculty	7
(*c*) Option rests freely with the students to take thesis or elect other work instead	8
Total	72

It is interesting to note that of the thirty-three schools requiring thesis

6 express no opinion regarding the requirement,
2 wish a change,
3 are doubtful regarding the requirement,
22 are satisfied,
33 total.

Of the twenty schools that have no thesis requirement

2 express no opinion regarding the requirement,
1 would like to establish a thesis requirement but is unable to do so because of local conditions,
1 is doubtful concerning the advisability of omitting the thesis,
16 are satisfied with no thesis,
20 total.

Another point of interest is that among the twenty schools that have abolished thesis the four following schools mention that they have made provision to give the student investigative work similar in nature to thesis work:

Carnegie Institute of Technology: "In some departments

work very similar to thesis work is given but no hours are definitely scheduled for this subject, the work referred to being incidental to a technical course. In other departments we are using the competitive problem work offered by the Engineers Society of Western Pennsylvania in place of what is required at many institutions in the way of a thesis."

Johns Hopkins University: "We are encouraging special investigations by senior students in connection with a number of senior courses."

Leland Stanford Junior University: "The work in the senior year is in the nature of a thesis to this extent, that specific problems are assigned to members of the senior class which are solved by them and are usually handed in in the form of a report accompanied by the necessary drawings."

Tulane University of Louisiana: "In the second semester of the senior year, the student is assigned a definite problem in design which is somewhat in the nature of thesis work, as it involves the discovery of things new to the student although they are not new to the expert."

Nature of Thesis.—No effort was made to ascertain either the nature of the thesis work or the methods of administration in other schools. In some of the replies, however, these points were covered. In regard to the nature of the work nothing appears that is not covered by our practice at Wisconsin. The following quotations show the usual range of the work:

The State University of Iowa, College of Applied Science: "Thesis must be an engineering design or an original investigation and never a review or compilation."

Minnesota School of Mines: "Our thesis work gives the student a review of nearly all technical subjects taken in his course in the form of special problems."

Virginia Polytechnic Institute: "I have two forms (of thesis) for the B.S. degree; I require the definite solution of a problem or a report on some subject. As a case in point this year one of my men for his B.S. degree is writing a report on the subject of superheated steam and another is designing the

general layout for a heating system for a large group of buildings. The method of instruction which I am developing and have been using for a number of years, more or less, in the senior year, is to use problems, and sometimes very extensive problems, for instruction purposes. As this becomes more definitely and more concretely developed it may take the place of the thesis entirely."

Administration of Thesis.—As before stated, no effort was made to ascertain the details of administration at the various schools; but the following information is available,—

Minnesota School of Mines: "We have a regular time allotted to this work when instructors are present in the drafting-room to direct and assist the students in their work."

New York University—School of Applied Science: "Our ideal includes one weekly meeting of the student with the professor under whose subject the students' thesis falls. This ideal is not always reached but it exists, and we look forward to the time when each senior will invariably meet his professor for one full hour every week."

University of North Dakota: "Thesis work can receive close inspection and the instructors are in close touch with the work as it progresses, although the students are allowed considerable latitude in their work and are given a chance to show their initiative and resourcefulness."

Rensselaer Polytechnic Institute: "Each student here must write a graduating thesis; and he must not only write it, but he must defend it. He reads it publicly, with a large drawing on the wall to illustrate it. This enables a searching examination to be made of his work, and now and then students are prevented from graduating on account of their theses."

Rose Polytechnic Institute: "Our custom is to concentrate all of the thesis work during the last eight weeks of the senior year when the entire time is given over to thesis."

The Purpose of the Thesis Requirement.

As previously stated, the Committee realized early in the investigation, that a correct answer to the thesis question

could not be obtained without first reaching a clear and definite understanding of what the requirement is intended to accomplish. Three possible purposes suggest themselves as follows:

1. To benefit the student by developing him along lines not possible through the work of the ordinary courses.

2. To advance engineering knowledge through original research.

3. To determine the student's capacity for independent work.

From the data at hand it seems quite evident that the attitude of teachers toward thesis work depends chiefly upon the conception held of the nature and purpose of the thesis. Apparently there are two theories regarding this matter. One theory is that the thesis should be, primarily, a piece of original and independent research. Those who hold to this conception and administer thesis accordingly, measure the value of thesis work by the value of the thesis produced. This attitude implies that thesis work loses its value, first, if the work is closely supervised and second if the finished thesis is not valuable from the standpoint of research. It is among those who hold to this theory that the greatest dissatisfaction with thesis exists. According to the second theory, the primary purpose of the thesis is to give the student a training that is not given in the regular courses. So long as the main object is attained, the nature of the thesis work and the degree of supervision under which it is carried out may be varied to suit the state of the students' educational development. Those holding to this conception consider the advancement of knowledge that may result from thesis work, desirable, but of decidedly minor importance.

It is hard to support either of these theories by argument; the choice between them is largely a matter of personal opinion. Of the two, the Committee believes the latter theory to be the better from a pedagogical standpoint. It became apparent early in the discussions that, as a matter of fact, thesis

was being used by a considerable number of instructors as a means for giving the students a definite training and that, consciously or unconsciously, the training was the prime object of the work and research a very minor one. Although some engineering teachers have an exalted ideal of thesis, no one has been found who, when the question is stated in simple terms, is willing to maintain that the prime object of thesis should be the advancement of knowledge.

Results of Thesis Work.

Is the purpose of the thesis requirement being accomplished? Probably not to the extent that it might be if the purpose of the requirement were thoroughly understood by all who are directing thesis, nor to the extent that it might be if all thesis directors were enthusiastic believers in the work. The agitation against the thesis requirement probably owes its origin, in large part, to poor results obtained from it. The nature of the work is such that it is not easy to fix the responsibility for failure in any given case. It may be due to lack of interest on the part of the student or it may be due to a failure on the part of the instructor, first, to appreciate the purpose underlying the requirement; second, to realize that the education of the student has not progressed to a point where he can do original and independent work; and third, to a failure to supervise thesis work in the proper manner.

In regard to the failure to appreciate the purpose of the requirement, it is not difficult to understand how a person having a high ideal of what a thesis should be; but uncertain notions as to why it is in the curriculum should become discouraged at the results produced. Believing that thesis should be original and independent research, he throws the student upon his own resources and fails to supervise him properly. This in itself, as will be seen presently, is enough in most cases to destroy whatever chance there might be to produce a creditable piece of work. In addition he measures results by the quality of the final output, which is apt to be mediocre at best,

rather than by the effect upon the student, which, if the work is handled properly, will be decidedly beneficial.

Regarding the ability of the student to do original and independent research work along engineering lines, it should be borne in mind that students in engineering courses, do not begin to specialize until the junior year and that the specialized education they receive previous to the senior year is small in amount and rudimentary in character. Therefore, at the time when thesis work is usually started, that is to say, early in the senior year, students are, as a rule, unprepared to do original and independent work along engineering lines with satisfaction either to themselves or to their instructors. There are, of course, occasional exceptions to be found among the more mature students and the students who have had some practical engineering experience; such men may be able to do independent work provided that they have acquired more or less judgment from their experience. But the student who lacks both experience and training, lacks also the judgment that is his rudder in navigating the uncharted sea of research. This should not, however, be advanced as an argument against giving the inexperienced student the training that will develop his judgment. The instructor who earnestly desires to do so, should be able to transfer to the student something of his own experience and judgment at the same time that he is instructing the student in methods of research.

It is evident from the foregoing that the method of administering thesis is of much importance. Under the conditions that exist it is essential that the director of a thesis should, in the majority of cases, maintain close contact with the work as it proceeds, in order that the student may not waste his time or acquire false impressions as a result of his work. To allow a student to reach wrong conclusions without correcting them and pointing out why they are wrong is worse than to deprive him of the training entirely. The degree of supervision should be so adjusted as to avoid, on the one hand, the danger of wrong impressions and wrong conclusions, and, on the

other hand, the danger of making the thesis a mere echo of the instructor's ideas rather than a reflection of the individuality of the student.

It is the opinion of the committee that the poor results, to which are due a large part of the dissatisfaction with thesis, are, in a large measure, caused by a lack of proper administration of the work, which in turn is due either to a lack of understanding of the nature of the work or a lack of interest in it.

But while it is doubtless true that much of the thesis work is of rather low quality, the fact that not all thesis work is considered unsatisfactory is evident from the testimony of many of the schools that still retain the requirement and rank it as the most beneficial of the whole course.

The State University of Iowa, College of Applied Science: "We believe the work put upon thesis is as valuable as, if not more valuable than any one course that we give."

Lehigh University, Department of Mechanical Engineering: "We really get very satisfactory results—the men take much interest in this work."

University of Minnesota—Minnesota School of Mines: "All heads of departments in our School of Mines consider thesis to be the most valuable work that the student has in his entire course."

The Ohio State University—College of Engineering: "Thesis as a pedagogical proposition is one of the best things that we give in our course of study."

University of Pittsburgh: "We believe it (thesis) to perform a very important and essential part in the work of the engineering department."

Rensselaer Polytechnic Institute: "If we were going to do away with anything here in our course we probably would do away with the graduating thesis last of all."

University of Utah—State School of Mines: "I regard the preparation of a thesis as a piece of more or less independent work that is of such value to the student that it ought not to be eliminated."

SHOULD THESES BE REQUIRED?

Importance of Thesis Training.

Is the purpose underlying the thesis requirement of sufficient importance to justify the retention of thesis as a required part of the curriculum? The committee believes it is. Properly administered, thesis work affords the student a training in planning an attack upon a more or less complicated question or problem, in collecting and analyzing data bearing upon it, in deducing logical conclusions from such data and in presenting the results of his work in proper form. The ability to do such work is of the utmost importance to the engineer in his active practice, and the lack of such training is a serious handicap to the young engineer who is beginning his career.

It has been urged that the young engineer will not need such training at school since it will be ten years after he is graduated before he is called upon to make responsible investigations and during that ten years he will have an opportunity to learn how the thing is done. This argument is defective for two reasons. In the first place it does not explain how the engineer is going to learn during his probationary period. He cannot learn without practice. Sometime or other he must make his first attempt at such work and the first attempt will, almost invariably, show the hand of the amateur. That engineer should be considered unfortunate who gets his "tryout" on an important job that may make or break him. It is much better that the man should have such training while still a student, under conditions that are most favorable to rapid development, and while he is still exempt from possible ruinous consequences in case of mistakes.

In the second place those members of the faculty who have testified on this point agree that the young engineer is called upon, very early in his career, to do work that can be done most successfully only by a man who has had training of this kind. For example, the young man in the drafting office is assigned to the task of preparing plans, say for converting a freight car into a travelling concrete plant. On a small scale

this is a problem of the thesis type. It is not a cut and dried problem capable of but one solution: no two men will produce exactly the same design. His solution will reflect his individuality and will reveal his ability to do original and independent thinking. If he cannot show that ability early in his career he soon drops into a minor place in whatever organization he may be. This is only one of many examples that might be used to illustrate the point.

That the thesis is considered of great importance in many engineering schools and especially in those where it is administered with thought and thoroughness, and that satisfactory results are being secured is demonstrated by the quotations already given under the discussion of results.

Is Thesis the Best Method of Giving the Desired Training?

Admitting the value of the training that has been discussed, the question may be raised whether that training could not be given in some other way, that would be less difficult to administer. Certainly the burden of providing subjects for thesis investigation and of giving individual attention to large numbers of students is no light one and if a method could be devised that would accomplish the desired result with less expenditure of effort it would be welcome; but the committee has been unable to discover a satisfactory substitute, except that, where the number of students to be handled is so great in proportion to the number of instructors available to direct the work that it is difficult to give the required amount of supervision to thesis, the committee can see no reason why the students could not be handled in groups, in seminary or thesis courses, and given a training approximating that given by individual thesis work.

Should Thesis be Elective?

As mentioned at the beginning of this report, the work of this committee was to investigate the question of making thesis

elective. This question has been answered in the preceding discussion; but there remain a few points in this connection that deserve consideration. The question naturally arises as to the number of students who probably would take thesis work if it were freely elective. From data at hand it appears that there are at least eight institutions which have made thesis freely elective. They advise as follows regarding their experience.

Cornell University—College of Civil Engineering: "Whenever a student asks for advice in regard to this subject our professors try to encourage them to write a thesis, providing they feel that he could do reasonably well in the premises. I should say from 15 to 20 per cent. of our students do choose thesis. As a matter of fact, last year there was just 17 per cent."

Cornell University—Sibley College: "This year (1914–15) there are about twenty-four seniors taking thesis out of a class of one hundred and eighty-six" (about 13 per cent.).

Michigan College of Mines (Houghton): "Very few of our students choose thesis."

University of Missouri: "Thesis has recently been made elective for the Civil Engineering Course only and there are no data regarding the number of students who choose thesis."

Oregon Agricultural College—School of Engineering and Mechanic Arts: "Bright students who are especially interested in special subjects are encouraged to do thesis work. The percentage (of students taking thesis) is rather small—I should say that it does not exceed 10 per cent. Probably more students in electrical engineering choose thesis than in any other course."

University of Texas: "The boys prefer to take a definitely prescribed course. Nearly all of those that have a choice take a university course in preference to a thesis."

University of Washington—College of Engineering: "Thesis is optional in the departments of civil and mechanical engineering. The elections for this year have been four out of

five for the thesis in the department of mechanical engineering, and six out of fourteen in the civil. The number of elections of thesis in the department of civil engineering have been smaller than we anticipated, and I think it is probable that we will use, at least, some persuasive powers to have more selections next year."

Worcester Polytechnic Institute, Department of Electrical Engineering: "About two-thirds to three-fourths of our men decide to substitute regular courses in place of thesis."

A study of the replies from these eight schools indicates that the percentage of students taking thesis under the elective system varies approximately with the esteem in which thesis work is held by the faculty of the school in question. If the feeling toward thesis is one of indifference or hostility few of the students elect thesis, whereas, if the thesis is looked upon as a valuable pedagogical feature, more or less pressure is applied to influence students to elect such work and a larger percentage of students do so elect. It appears, therefore, that we might expect to have from practically none up to perhaps 20 per cent. of the students elect thesis, depending upon the attitude of our faculty toward the work. Probably 15 per cent. of thesis elections would be what we could reasonably expect under a free elective system.

It seems to the committee that it would be a mistake to permit 85 per cent. of the students of this college to leave the school and go out into active work without the training that thesis provides.

As for the proposal to limit thesis election to the higher grade of students, the committee is opposed to the idea of discriminating between students in this matter. It is believed that every student is entitled to full opportunity to perfect himself and that it is both unfair and unwise to attempt to limit thesis work, together with its accompanying benefits, to any particular class of students.

The argument that only a small percentage of students are capable of doing thesis work, while it might carry weight if

the primary object of the work were to advance research, loses its force altogether if thesis is to be considered as a means of training the student. Measured by its effect upon the development of the student the thesis may well be of as much or greater benefit to the poor or mediocre student as to the high grade student.

The committee has been unable to find any convincing argument why thesis should be made elective.

Conclusions.

The committee therefore submits, as the results of its investigations and discussions, the following findings as to the purpose of the thesis requirement, the principles that should govern its administration, and its place in engineering curricula:

Findings of the Committee.

1. The baccalaureate thesis is intended primarily to benefit the student; any contribution to engineering knowledge, although desirable, is of purely secondary importance.

2. The benefit to the student comes through the training that he receives in planning an attack upon a more or less complicated question or problem, in collecting and analyzing data bearing upon it, in deducing logical conclusions from such data and in presenting the results of his work in proper form. He has also the advantage of the stimulus which comes from critical and intimate discussion with the instructor of the ideas, methods and results brought out by the investigation.

3. It makes little difference, so far as benefit to the student is concerned, whether the work is of laboratory, design, library or seminar character.

4. Undergraduate thesis work should be properly supervised, otherwise the student may receive harm rather than benefit. At the beginning of his senior year, when he should start thesis work, the student usually has not progressed far enough in his engineering education to be able to carry on an

investigation without careful supervision. The supervision should not be of such extent, however, as to make the thesis the work of the instructor instead of the student.

5. It is desirable that certain formalities should be observed in regard to thesis, such as requiring the results to be typewritten, bound and deposited in the library. The necessity of preparing the material for typewriting and the knowledge that a record of the work is on file, is believed to insure a more careful preparation of theses and, in general, to maintain a higher standard of work than would otherwise be the case.

6. The training which the student receives from thesis work is of a nature different from that obtained in the usual prescribed studies. It is believed that this thesis training is of such importance that it should be given to all, and therefore that the thesis requirement should be retained in the engineering curricula.

APPENDIX.

Thesis Requirements in Engineering Schools. Alphabetical Arrangement.

Alabama Polytechnic Institute	Thesis required.
Alabama, University of	No thesis.
Arkansas, University of	Thesis required.
Armour Institute of Technology	Thesis required.
Brooklyn Polytechnic Institute	Thesis required.
California, University of	Thesis required.
Case School of Applied Science	Thesis required.
Carnegie Institute of Technology	No thesis.
Clarkson College of Technology	Better students only allowed to take thesis.
Clemson Agricultural College	Thesis required.
Colorado, University of	Thesis required, substitution permitted.
Cornell University, College of Engineering	Thesis freely elective.
Drexel Institute	No thesis.
Florida, University of	No thesis.
George Washington University	No thesis.
Harvard University	No thesis.
Idaho, University of	Thesis required.
Illinois, University of	Better students only allowed to take thesis.

Iowa State College	Thesis required.
Iowa State University	Thesis required.
Johns Hopkins University	No thesis.
Kansas State Agricultural College	Thesis required.
Kansas, The University of	Thesis required.
Kentucky, State University of	Thesis required.
Lehigh University	Thesis required.
Leland Stanford Junior University	No thesis.
Lewis Institute	No thesis.
Massachusetts Institute of Technology	Thesis required.
Mechanics Institute	Thesis required.
Michigan Agricultural College	Thesis required.
Michigan College of Mines	Thesis freely elective.
Michigan, University of	No thesis.
Minnesota School of Mines	Thesis required.
Minnesota, University of	No thesis.
Mississippi, University of	No thesis.
Missouri School of Mines and Metallurgy	Thesis required.
Missouri, University of	Thesis freely elective.
Montana State College of Agr. and Mechanics	Thesis required.
Nebraska, University of	Better students only allowed to take thesis.
New Hampshire College	Better students only allowed to take thesis.
New York University	Thesis required.
N. Dakota Agricultural College	No thesis.
N. Dakota, The University of	Thesis required.
Northwestern University	Thesis required.
Ohio State University	Thesis required.
Oklahoma, The University of	Thesis required, substitutions.
Oregon Agricultural College	Thesis freely elective.
Pittsburgh, University of	Thesis required.
Pennsylvania State College	No thesis.
Princeton University	Thesis required.
Purdue University	Thesis required, substitutions.
Rensselaer Polytechnic Institute	Thesis required, substitutions.
Rhode Island State College	Better students only allowed to take thesis.
Rose Polytechnic Institute	Thesis required.
Sibley College, Cornell University	Thesis freely elective.
Sheffield Scientific School	No thesis.

S. Dakota State College	No thesis.
Stevens Institute of Technology	No thesis.
Texas A. & M. College	No thesis.
Texas, University of	Thesis freely elective.
Toronto, University of	Thesis required.
Tufts College	Thesis required, substitutions.
Tulane University of Louisiana	No thesis.
University of Utah School of Mines	Thesis required.
Valparaiso University	Thesis required.
Vanderbilt University	No thesis.
Virginia Polytechnic Institute	Thesis required.
Vermont, University of	Better students only allowed to take thesis.
Washington University	Better students only allowed to take thesis.
Washington, University of	Thesis freely elective.
West Virginia University	Thesis required.
Worcester Polytechnic Institute	Thesis freely elective.

Thesis Requirement in Engineering Schools. Arranged According to Requirement.

Alabama Polytechnic Institute	Thesis required.
Arkansas, University of	Thesis required.
Armour Institute of Technology	Thesis required.
Brooklyn Polytechnic Institute	Thesis required.
California, University of	Thesis required.
Case School of Applied Science	Thesis required.
Clemson Agricultural College	Thesis required.
Idaho, University of	Thesis required.
Iowa State College	Thesis required.
Iowa State University	Thesis required.
Kansas State Agricultural College	Thesis required.
Kansas, The University of	Thesis required.
Kentucky, State University of	Thesis required.
Lehigh University	Thesis required.
Massachusetts Institute of Technology	Thesis required.
Mechanics Institute	Thesis required.
Michigan Agricultural College	Thesis required.
Minnesota School of Mines	Thesis required.
Missouri School of Mines and Metallurgy	Thesis required.
Montana State College of Agr. and Mechanics.	Thesis required.
New York University	Thesis required.
North Dakota, The University of	Thesis required.

Northwestern University	Thesis required.
Ohio State University	Thesis required.
Pittsburgh, University of	Thesis required.
Princeton University	Thesis required.
Rensselaer Polytechnic Institute	Thesis required.
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SHOULD THESES BE REQUIRED?

Nebraska, University of	Better students only allowed to take thesis.
New Hampshire College	Better students only allowed to take thesis.
Rhode Island State College	Better students only allowed to take thesis.
Vermont, University of	Better students only allowed to take thesis.
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Sibley College, Cornell University	Thesis freely elective.
Texas, University of	Thesis freely elective.
Washington, University of	Thesis freely elective.
Worcester Polytechnic Institute	Thesis freely elective.

A CHEAP SUBSTITUTE FOR THE SLIDE-RULE.

BY F. CASTIGLIONI,

Electrical Engineer, New York, N. Y.

The writer does not pretend that these notes outline a discovery, but believes that the subject matter would be found of assistance to the engineer or the technical man who has to make some quick approximate calculations and discovers that no slide-rule is at hand, and yet finds it worth while to use a simple substitute thereof If some of the readers find it obvious, other readers will take advantage of the hint.

It will be shown that the curve in Fig. 1 allows the same number of diversified operations, the same precision and on the average the same speed as the slide-rule, with the added advantage that it can easily be prepared by anyone on ordinary cross-section paper in a few seconds, and on as large a scale as may be desired.

The name of this curve is properly " the logarithmic curve," which to the initiated explains the whole question without need of further words, but it might also be called " universal curve," and for the uninitiated and for the forgetful, it will be of interest to follow the notes here below to make its usefulness apparent.

It is not necessary to go over the whole theory of the logarithms which can be found in any book. Our curve is plotted by connecting the values of the decimal logarithms which are plotted against the corresponding numbers in a system of coördinates, these logarithms being found in the first table at hand. As scale for the numbers, we can choose from 1 to 10, this being the most advantageous one for rapid and correct setting of the decimal point in the final result, and as we only care for the characteristics of the logarithms and these would be self-repeating for all multiples of 10, said scale is all that is needed.

The great advantage of the curve is that it gives the graphic values of the logarithms, for, remembering that the operations with the logarithms are ordinarily the sum and the subtraction with some simple multiplication and division, that is just what can be easily done graphically.

The use of the logarithmic curve is practical for following purposes:

Given a number, to find its logarithm, and vice versa.

Speaking first of the decimal logarithm, cut the curve with an abscissa passing through the number (absolute value) and through the intersection with the curve extend the ordinate to cut the logarithmic scale. This will give the characteristic of the logarithm in question and about its mantissa we must remember that it is 0 for numbers from 1 to 9.99; 1 for numbers from 9.99 to 99.99; 2 for numbers from 99.99 to 999.99, etc., and -1 for numbers from 0.1 to 0.99; -2 for numbers from 0.01 to 0.099, etc. For the opposite case, proceed in the opposite way.

For certain calculations it is necessary to have "natural logarithms" which have as basis $e = 2.7182\ldots$. A glance at the logarithmic tables will show us that log nat/log dec = 2.30259, or that log nat = 2.30259 $\times$ log dec. If the log nat of a number is required, we can first find the log dec and then scale off in our logarithm scale the ordinate between the log dec in the straight line with the Tang $\alpha = 2.30259$ shown in Fig. 1. To this the product 2.302 $\times$ mantissa of the log dec has to be added. Inversely, if the number corresponding to a log nat has to be found, the operation requires some more attention, but is not difficult. First scale off the log nat with its mantissa considering it as a number in the scale for the numbers, remembering that the scale starts from 1 and not from 0 and, therefore, that we must take the mantissa plus one. Find then the corresponding abscissa to the line for Tang $\alpha = 2.30259$ and scale it off again in the number scale, which subtracting one gives us the log dec with its mantissa. Consider for the moment the characteristic alone and pro-

ceed as already explained for finding the number corresponding to a log dec.

Reciprocal Numbers.—The log dec of $1/N$ being equal to $1-N$, to find log $1/N$, we first set the dividers for the log dec N and transport this setting, starting from the right end of the log scale, then follow the ordinate to cut the log curve and then the abscissa to the corresponding numbers.

Multiplication and Division.—As multiplication and division of numbers mean addition and subtraction, respectively, of their log and subsequent finding out of the number corresponding to the result, it follows that we can quickly perform these operations by means of dividers or even better by using a strip of paper on which we can consecutively add and subtract the graphic values of the log corresponding to the numbers in question. If the sum is greater than five inches, which in our scale corresponds to log dec 10, this means that the result is greater than 10, and as we only care for the characteristic of the log, this simply means that we consider that portion of the result which remains after having subtracted as many times as possible the five inches of the entire log scale. In division the result is very likely to be negative, but this makes no difference, because this will influence the mantissa, whilst we find the number corresponding to the characteristic in the usual way.

In case the term to be solved has the form $A \times B \times C \times \ldots a \times b \times c \times \ldots$ different ways can be followed with the strip of paper, either performing first log A + log B + log C, etc., and then subtracting log a, then log b, log c, etc., or considering first log A — log a, adding then log B, subtracting log b, etc.

It is not claimed that these operations can be performed more quickly than by using the slide-rule, but after having acquired a little experience in the use of the strip of paper one ought not to regret too much to have forgotten the slide-rule if he can find the logarithmic curve in his pocketbook.

Powers and Roots.—Powers and roots are obtained by mul-

tiplying or dividing the log by the exponent and then finding the corresponding number. For any exponent we can

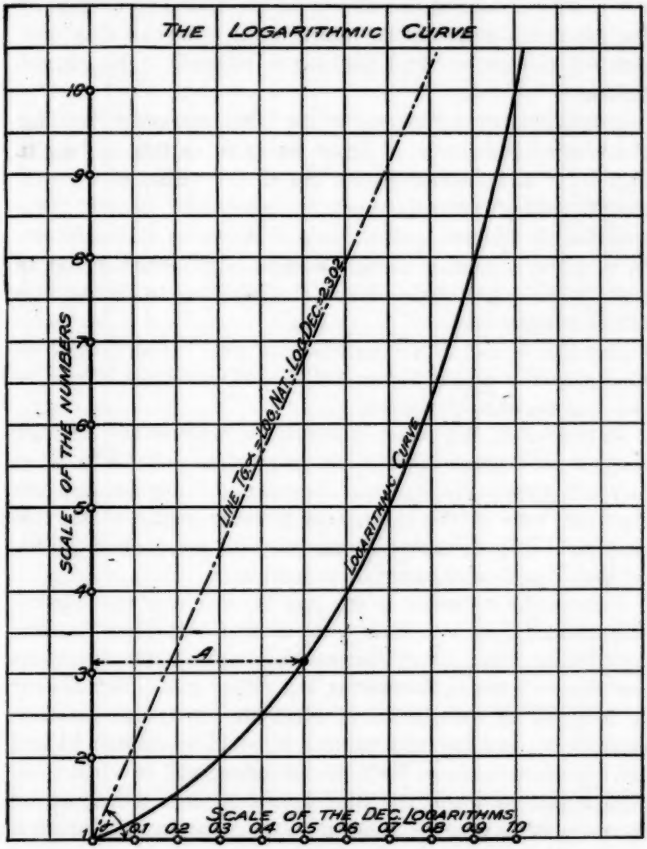


FIG. 1.

quickly perform the graphic multiplication or division of the log and if a certain high exponent (N) is forthcoming rather

often, we can prepare a line with Tang $\alpha = N$ as a ready help for the purpose. Before finding the number, we must remember that the mantissa has also to be multiplied or divided by the exponent, which in the case of roots means an easy division but also an eventual addition to be made to the characteristic.

Generally, the log curve can be advantageously used for the numerical solution of many formulæ, as this is done in Fig. 1 for π, introducing once for all the values of the constants most frequently used in everyday routine. For example, if frequent calculations of moments of inertia are to be made, a further useful addition to the chart would be that of the logarithmic curve corresponding to the squares of the numbers, etc.

In order to add to the usefulness of Fig. 1, Fig. 2 could be also prepared which represents the "logarithmic curves of the trigonometric functions."

In regard to this chart it should be remembered that the scale of the degrees ought to be as great as possible, so as to enable the user to take care of the seconds of degrees, and also that the scale of the logarithms is conveniently chosen the same as in Fig. 1, thus allowing the joint use of both figures without complicating graphic reductions.

It is hardly necessary to say that the values of the trigonometric functions are most conveniently expressed in this logarithmic form, firstly because the trigonometric functions are rarely of use in themselves, but rather more often appear in formulæ for the solution of which the logarithms are more convenient; and secondly because it would be difficult to find the approximate scales for tang and cotang and to adopt them for sin and cos, whilst the logarithms with their self-repeating characteristics offer no difficulty. As regards the mantissas a tabulation is given in Fig. 2.

If it is required to know the value of these trigonometric functions, first find their logarithms in Fig. 2, then the equivalent numbers in Fig. 1.

It will be noted that in Fig. 2, the scales for sin and cos are opposite, due to the fact that sin $\alpha = \cos(90 - \alpha)$. Further-

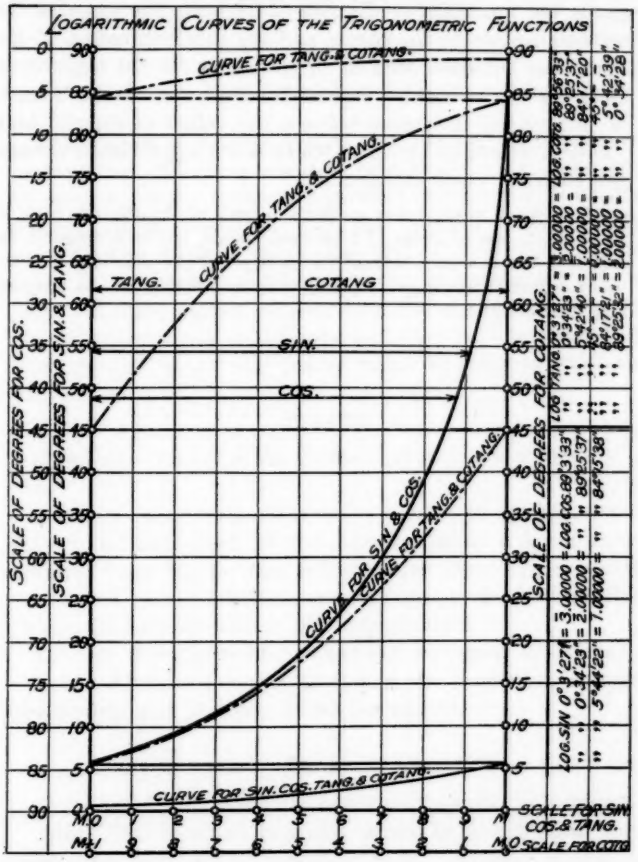

LOGARITHMIC CURVES OF THE TRIGONOMETRIC FUNCTIONS
CURVE FOR TANG. & COTANG.
CURVE FOR TANG. & COTANG.
TANG.
COTANG
SIN.
COS.
CURVE FOR SIN. & COS.
CURVE FOR TANG. & COTANG.
CURVE FOR SIN. COS. TANG. & COTANG.
SCALE OF DEGREES FOR COS.
SCALE OF DEGREES FOR SIN. & TANG.
SCALE OF DEGREES FOR COTANG.
SCALE FOR SIN. COS. & TANG.
SCALE FOR COTG.

FIG. 2.

more, being the cotangent the reciprocal of the tangent, the log for cotang have to be read starting from the right side as

indicated in the lowest scale. As indicated for the tabulation for the mantissas, these functions have a wide range as regards the multiples or divisors of 10, and this explains the sectionalization of the curves and the indetermination of the mantissas indicated with *M* in the scales for the logarithms. Note that up to about 7 degrees for the scales chosen there is no appreciable difference between the values of sin and tang (or between cos and cotang) which is but approximate enough for ordinary quick calculations. *

* It might be asserted that another substitute of the slide-rule could be found in the use of strips of logarithmic paper, but in addition to the fact that this is a pure copy of the principle of the slide-rule, it is not believed that it would be as plain, quick and precise as the proposed logarithmic curves.

A QUIZ ON QUIZZES.

BY W. H. RAYNER,

Instructor in Civil Engineering, University of Illinois.

The subject of written quizzes and examinations is an important one, and there seems to be a considerable difference of opinion among teachers regarding certain phases of this subject. It is, therefore, with the purpose of stimulating some discussion, from which some helpful suggestions should come, that I propose the following set of questions. I have answered these myself without any claim that they are the correct answers, but in the hope that they will be sufficiently suggestive to induce the reader either to approve or disapprove them.

Purpose.

Question. (A) For the student, what is the purpose of a quiz?

Answer. A quiz should give the student an opportunity to collect his ideas which he may have gained in a disconnected manner from day to day, and organize them into a unified conception. It should therefore cause him to think and should in no wise have the nature of a memory drill.

Q. (B) For the teacher, what is the purpose of a quiz?

Ans. From the results of a quiz the teacher may judge the quality and efficiency of his instruction.

Criteria.

Q. Shall the questions be general or specific in nature?

Ans. The questions as a rule should be specific, and those beginning with the all inclusive word "discuss" should be avoided. Moreover the questions should be perfectly definite, leaving the student no opportunity to evade them by assuming that he misinterpreted them.

Q. Are catch questions permissible?

Ans. Any attempt to catch the students off their guard is outlawed but this does not mean that questions must always be put in a form familiar to the student.

Q. Shall all questions have the same weight?

Ans. Not necessarily; questions are like paragraphs and should deal with a single subject. However the student should know what weights have been assigned the various questions.

Q. Shall the questions be limited to the subject matter covered since the last quiz?

Ans. No. They may seek to correlate ideas recently gained with any subject previously taught, to which they apply.

Q. How long should a quiz be?

Ans. No quiz should be so long that the student's attention will be unduly detracted from the subject under examination, by a fear that his time is limited. Some teachers assume that in solving a problem in a quiz, the average student should be allowed twice as much time as it required the instructor to solve it.

Methods.

Q. Shall the date of a quiz be announced?

Ans. For the best pedagogic results, quizzes should be announced in order that the student may gather together the principles he has studied, "at the burning point of interest," under the compelling force of a knowledge that a written quiz is imminent.

Q. How shall the questions be presented to the students?

Ans. It matters little whether the questions are written on the board or mimeographed, if in every case the writing or print is legible and will not strain the eyes of the student.

Q. Shall the questions be given with or without the use of text-books?

Ans. If practicable the use of books should be permitted,

but the student should never know in advance whether or not the use of books will be allowed.

Q. Shall papers be returned to the student?

Ans. Yes, except in the case of students who fail. In these cases the papers must be kept to be used as evidence in any controversy with the student.

Q. What means shall be taken to assure the teacher that the student has profited by his mistakes in the quiz?

Ans. Questions on which most students failed should be repeated in a different form in a subsequent quiz. Other questions should be reviewed in class to bring out the points overlooked or misconceived by the students.

Grading.

Q. Should the personality of the student be a factor in fixing the grade?

Ans. Ultimately yes, but not while the paper is being graded. The student's name should appear on the outside of the paper only, so that no names will be apparent during the grading of the papers.

Q. In computations, what weights should be given to accuracy of results and method?

Ans. Under the stress of a quiz, method must be given more consideration; say a weight of two and accuracy, one. In ordinary problem work, these weights should be equal. (By accuracy, is meant a result correct within reasonable limits consistent with the purpose for which the computations are made.)

Q. How shall the class average be taken into account?

Ans. The actual grades on the scale of 100 should be given the students but in the class record of course, due allowance must be made for low class averages. For instance on a given quiz the average grade for a class is 60 where 85 is considered average work, then each grade must be increased by 25 per cent.

Cribbing.

Q. Should the instructor remain in the room during a quiz?

Ans. This question will be answered differently, depending on the point of view taken; if it is assumed that the university has the duty of seeking out and punishing the guilty students; of protecting the innocent against the unfair means used by cribbers, then a teacher or proctor will police the quiz with as careful surveillance as possible. If however, it is assumed that it is not the function of an educational institution to act as watchman during an examination and that the sum total of cheating is likely to be less if students are put on their honor, then no official will be present during a quiz.

Q. What precautions are legitimate?

Ans. 1. Paper should be furnished by the university. 2. Students should not be placed so that they cannot help seeing their neighbor's paper, or if this cannot be avoided, two sets of questions should be used.

Q. What disciplinary action should follow convictions for cribbing?

Ans. This problem should probably be left to the teacher to decide, for there are many degrees of obliquity in this matter, though this course has the danger that the same offence will not receive the same treatment in all cases and injustice will be done. However the aim of punishment should be to reform the offender and this in turn will require a variable scale of penalties.

Editor's Note.—The author will be glad to receive any opinions on any one or more of these questions and from such replies possibly a composite series of answers can be derived which shall represent the opinions of a large number of teachers or practitioners which would have considerable weight in guiding our practice in regard to quizzes and examinations.

JOINT COMMITTEE ON STANDARDS FOR GRAPHIC PRESENTATION.

PRELIMINARY REPORT PUBLISHED FOR THE PURPOSE OF INVITING SUGGESTIONS FOR THE BENEFIT OF THE COMMITTEE.[1]

As a result of invitations extended by The American Society of Mechanical Engineers, a number of associations of national scope have appointed representatives on a Joint Committee on Standards for Graphic Presentation. Below are the names of the members of the committee and of the associations which have coöperated in its formation.

WILLARD C. BRINTON, *Chairman*, American Society of Mechanical Engineers. [7 East 42d Street, New York City.]

LEONARD P. AYRES, *Secretary*, American Statistical Association. [130 East 22d Street, New York City.]

N. A. CARLE, American Institute of Electrical Engineers.

ROBERT E. CHADDOCK, American Association for the Advancement of Science.

FREDERICK A. CLEVELAND, American Academy of Political and Social Science.

H. E. CRAMPTON, American Genetic Association.

WALTER S. GIFFORD, American Economic Association.

J. ARTHUR HARRIS, American Society of Naturalists.

H. E. HAWKES, American Mathematical Society.

JOSEPH A. HILL, United States Census Bureau.

HENRY D. HUBBARD, United States Bureau of Standards.

ROBERT H. MONTGOMERY, American Association of Public Accountants.

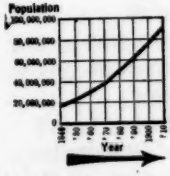
HENRY H. NORRIS, Society for the Promotion of Engineering Education.

[1] Copies may be had from The American Society of Mechanical Engineers, 29 West 39th St., New York. 10 cents each. Discount in quantities.

ALEXANDER SMITH, American Chemical Society.
JUDD STEWART, American Institute of Mining Engineers.
WENDALL M. STRONG, Actuarial Society of America.
EDWARD L. THORNDIKE, American Psychological Association.

The committee is making a study of the methods used in different fields of endeavor for presenting statistical and quantitative data in graphic form. As civilization advances there is being brought to the attention of the average individual a constantly increasing volume of comparative figures and general data of a scientific, technical and statistical nature. The graphic method permits the presentation of such figures and data with a great saving of time and also with more clearness than would otherwise be obtained. If simple and convenient standards can be found and made generally known, there will be possible a more universal use of graphic methods with a consequent gain to mankind because of the greater speed and accuracy with which complex information may be imparted and interpreted.

THE FOLLOWING ARE SUGGESTIONS WHICH THE COMMITTEE HAS THUS FAR CONSIDERED AS REPRESENTING THE MORE GENERALLY APPLICABLE PRINCIPLES OF ELEMENTARY GRAPHIC PRESENTATION.



1. The general arrangement of a diagram should proceed from left to right.

Fig. 1.

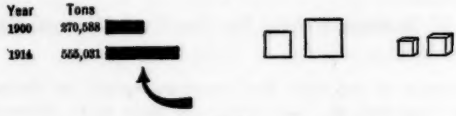


Fig. 2.

2. Where possible represent qualities by linear magnitudes as areas or volumes are more likely to be misinterpreted.

3. For a curve the vertical scale, whenever practicable, should be so selected that the zero line will appear on the diagram.

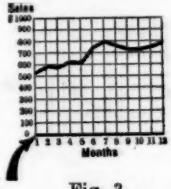
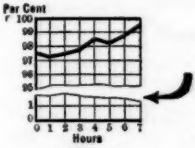


Fig. 3.



4. If the zero line of the vertical scale will not normally appear on the curve diagram, the zero line should be shown by the use of a horizontal break in the diagram.

Fig. 4.

5. The zero lines of the scales for a curve should be sharply distinguished from the other coördinate lines.

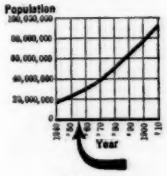


Fig. 5A.

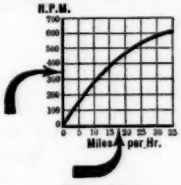


Fig. 5B.

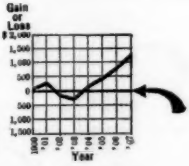


Fig. 5C.

6. For curves having a scale representing percentages, it

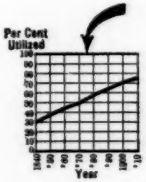


Fig. 6A.

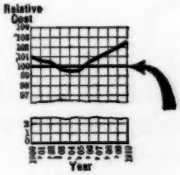


Fig. 6B.

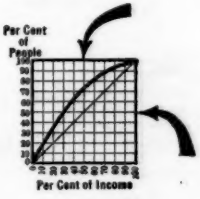


Fig. 6C.

is usually desirable to emphasize in some distinctive way the 100 per cent. line or other line used as a basis of comparison.

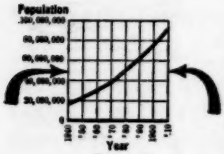


Fig. 7.

7. When the scale of a diagram refers to dates, and the period represented is not a complete unit, it is better not to emphasize the first and last ordinates, since such a diagram does not represent the beginning or end of time.

8. When curves are drawn on logarithmic coördinates, the limiting lines of the diagram should each be at some power of ten on the logarithmic scales.

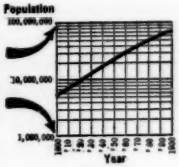


Fig. 8.

9. It is advisable not to show any more coördinate lines than necessary to guide the eye in reading the diagram.

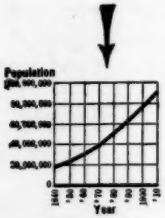


Fig. 9A.

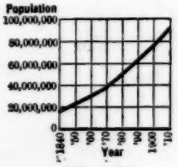


Fig. 9B.

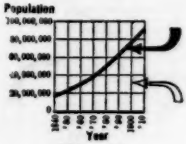


Fig. 10.

10. The curve lines of a diagram should be sharply distinguished from the ruling.

11. In curves representing a series of observations, it is

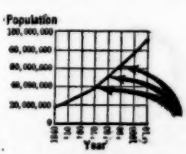


Fig. 11A.

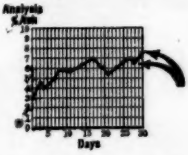


Fig. 11B.

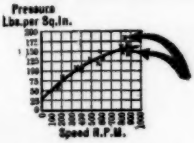


Fig. 11C.

advisable, whenever possible, to indicate clearly on the diagram all the points representing the separate observations.

12. The horizontal scale for curves should usually read from left to right and the vertical scale from bottom to top.

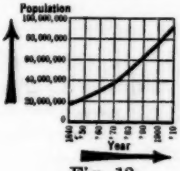


Fig. 12.

Fig. 13A.

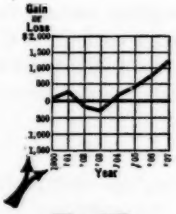


Fig. 13B.

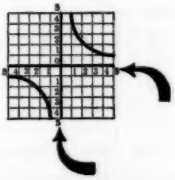


Fig. 13C.

13. Figures for the scales of a diagram should be placed at the left and at the bottom or along the respective axes.

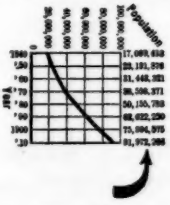


Fig. 14A.

Fig. 14B.

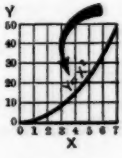
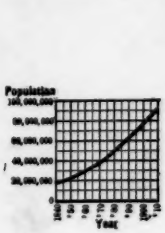


Fig. 14C.

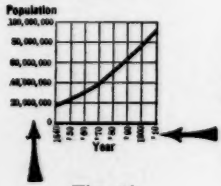
14. It is often desirable to include in the diagram the numerical data or formulae represented.



Year	Population
1840	17,069,453
1850	23,191,876
1860	31,443,321
1870	38,558,371
1880	50,155,783
1890	62,622,250
1900	75,994,575
1910	91,972,266

Fig. 15.

15. If numerical data are not included in the diagram it is desirable to give the data in tabular form accompanying the diagram.



16. All lettering and all figures on a diagram should be placed so as to be easily read from the base as the bottom, or from the right-hand edge of the diagram as the bottom.

Fig. 16.

17. The title of a diagram should be made as clear and complete as possible. Sub-titles or descriptions should be added if necessary to insure clearness.

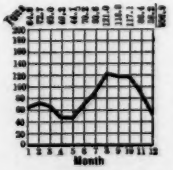


FIG. 17. ALUMINUM CASTINGS OUTPUT OF PLANT NO. 2, BY MONTHS, 1914. Output is given in short tons. Sales of scrap aluminum are not included.